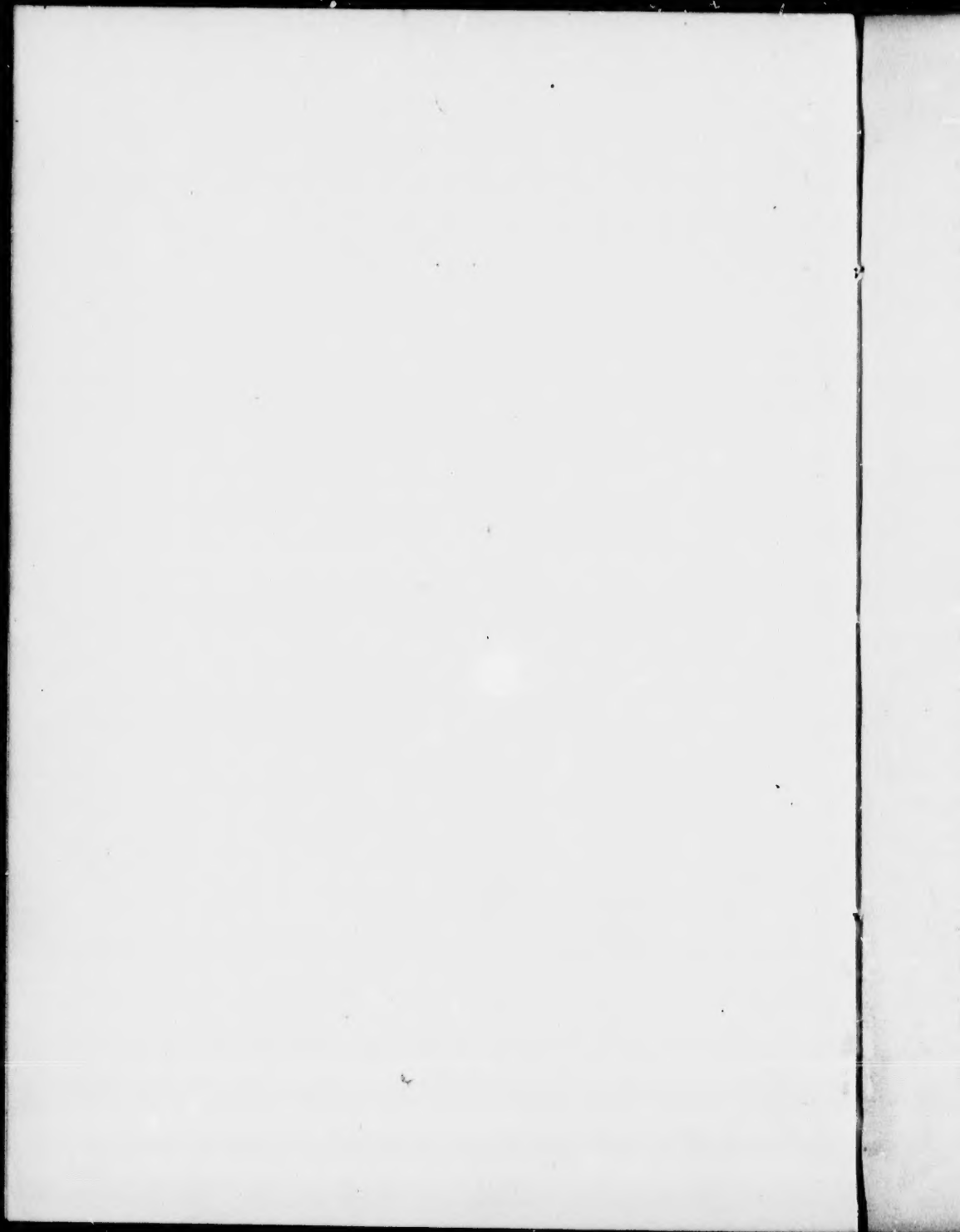




Paper on the Working of Traffic Upon Single-Track Railroads in Canada and the United States.

READ BEFORE THE BRITISH SCIENTIFIC ASSOCIATION, AT THEIR MEETING
IN MONTREAL, CANADA, AUGUST, 1884, BY W. K. MUIR.

When I accepted the invitation of your worthy Secretary to prepare and read before this body of scientific gentlemen a paper on the working of trains upon single track railways, I little imagined at the time, what I afterwards discovered, that to do justice to the subject it meant inflicting upon you the reading of an almost entire set of railroad regulations, that possibly might occupy two of your sessions, and that nothing less than a torpedo signal might be called into requisition to cut short my epistle!

In sketching the bare outline I tried ~~very~~ ^{best} hard indeed to keep on the main track of my subject, ~~yet~~ ^{but} I frequently found myself "switching off" on to branch lines, and that although diverging apparently, were ~~yet~~ really important "feeders" to the "main line," but which would make this manuscript journey too long for your patient consideration, so I reluctantly, as it were, "ran past" several switches trying to make my trip within a reasonable portion of your time, and that will be my apology if I fail in fully touching upon the innumerable details that ~~do~~ work into the regulating of train service, especially upon a single track railroad.

Well it will be unnecessary here, to refer to the various methods that have been in existence in Europe for working traffic upon single track railroads, the Baton or colored staff system with their colored tickets, the various electric block and electric telegraph signals from and to signal cabins, and the conductor with his red coat, or red cap, who alone was authorized to pilot a train over a division of single track, or the working in this country by time card only—and when trains got behind time and irregular, having the train men flag their trains along until they saw the opposing train, having then no telegraph arrangements to fall back upon, nor to a more recent period when the telegraph arrangements that were made by and between conductors to meet and pass their own trains, and latterly between agents and operators, for the conductors, with trains to approach and pass when running behind the time set in their working card, ~~and when~~ ^{the} station agents having so many duties to perform often ~~carried these~~ telegraphic train arrangement orders in their teeth, to make sure they would not forget them when the train reached the station, nor to the reason why so many single track railways were and are built in this country, because you will possibly admit we are a “go ahead” people—must have transportation, and if we had money to build only one mile of your description of double track, we would elongate it, make it two of our single track to cover the most ground with the least money, and in the shortest time.

You will readily see, that in getting rid of the ox teams and the lumbering stage coaches with their long and wearisome journeys, and preparing to substitute the iron horse in the development of new districts, and opening up and populating vast territories and making regions productive that would otherwise have remained a wilderness in this great country, where everything moves rapidly, for we have the *climate* and the boundless *resources* and the *territory* to take care of millions of people, we have had to get, not only Government aid

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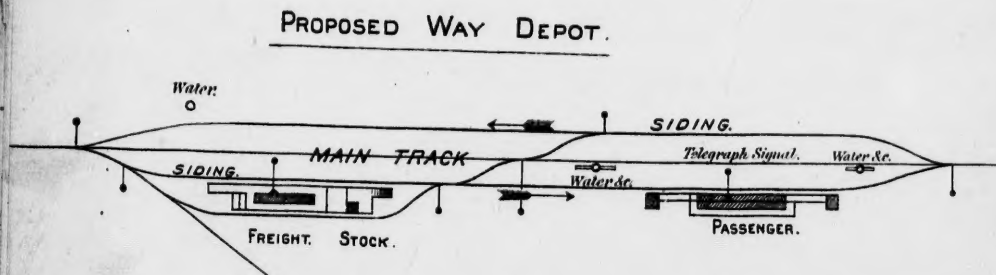
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and bonuses from the various counties and townships and cities and towns through which the railroads run, but also aid from your side of the Atlantic, and even then, with what capital we could raise we ~~have had to~~ ^{with ~~bad~~ ~~track~~} operate our great net work of single track railways ~~in the most economical and ingenious way~~ ^{imaginable}, and not being subject to the kind of Government supervision under which old country railways are *built, inspected and operated*, we have not the complicated, expensive system of interlocking signals, and switches and the numerous signal cabins, and electrical block and telegraph machinery and appliances, that I might almost say ~~are~~ ^{beginning} to encumber the railroad working in Europe, splendid and thorough though they be, but by and bye, we may come to them, when we have the traffic these roads enjoy, and when we have more compensation here for doing our work of transportation, and consequently better able to afford such an extensive staff and mechanical appurtenances.

Now let me try briefly to explain to you what is supposed to be about the best way in this country of operating our single track railroads. We shall suppose then, that the track is laid and, fenced and in reasonably good condition, the rails well tied (we call sleepers, ties), the track in line to gauge, and properly levelled, the outside curve rail laid upon acknowledged rules as to height, sufficient ballast, and drainage, equipped with a proper telegraph line and offices, ~~that~~ ^{being} the rolling stock and other equipment ~~is~~ ^{also} in good repair, for with bad track, defective locomotives and cars (especially freight), unfitted for the service now required of them, it would be hard indeed to make any kind of acceptable running time either by time card, or with the assistance of the telegraph.

There should be stations or side tracks about five miles apart, according to suitable location, upon as much as possible level grades, and the approach from either end to them upon a straight track; I would suggest that a side track, the length to

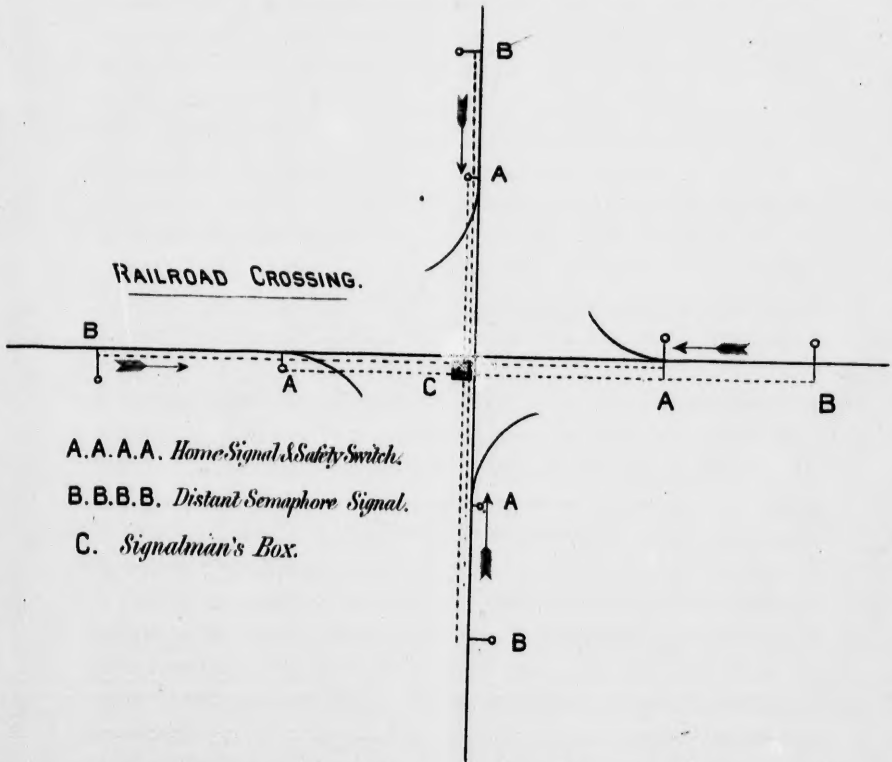
be determined by the amount of traffic to be moved, should be laid on each side of the main track at these places, with a three-throw switch at each end, and a three-throw switch in the middle, thus having only three switches in the main track; the discs and lights on the switches should show which way the switch was thrown; these tracks should accommodate several trains on their respective sides of the main track, bound in opposite directions, and would also permit of trains bound in the same direction getting out of the side track when in the rear, and when they had to take precedence, without disturbing the train ahead.



The tracks for the business of the depot should diverge from these side tracks, so that cars standing at the station would not be in the way of, or be interfered with, by trains switching to meet or pass others; the location of water columns and fuel platforms, should be such as would permit of this service being promptly performed while the train stood at the depot for traffic purposes.

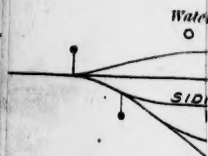
There should be a distinctive mark distant from, and upon

each side of all level roadway-crossings, so that the engineer could readily see it night or day, to give warning of his approach, and if the topography of the country admits, there should be no crossing of other railways upon the level, but when upon the level, there should be in use, the safety-switch on each side of the crossing, worked from the signal man's box, the home-signal attached to the switch-gearing, the switch always set for the siding and the danger-signal shown, except when changed with the switch to let a train proceed, so that no



the working of the traffic. For instance the necessity for:

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Draw-bridge approaches should have the same kind of safety-switch; stations, junctions and side-tracks should be provided with spectacled- semaphore arms and lamps; I think these distant semaphores are safer than the pole and ball or semaphore-arm signals *set up close by* junctions and crossings.

Level-crossings in cities and towns, in addition to gates and gatemen, should be protected by electric bells, worked by the trains as they approach; signal-towers can also be profitably used and with increased safety to the public and train service, not only on some portions of the main track, but at level-crossings and at junctions and yards.

If the road should unfortunately have a draw-bridge, ~~that~~ *it* should be worked with an electric signal attachment so that when the continuity of the main track is disturbed, there shall be both *bell* and semaphore-signals at a distance, and these heard and seen by the bridgetender so that he would know they were working.

There are a great many other points I could name, but the question is, how much should the condition, or construction of the roadway, and the condition of the plant and rolling-stock enter into this subject. These are some of the "switches" that side-tracked me, as I have said, when I started upon my paper journey! and yet they are all, in their way, important in the working of the traffic. For instance the necessity for:

Safety-switches, so that cars could not get off the track when switches were not set for it ;

Stringers and guard-rails upon bridges and trestle-work ;

Safety wing-rails and frogs approaching all bridges and trestles ;

Distant and home-signals and mode of working them ;

The blocking of wing-rails and frogs for safety to train, yard and switchmen ;

The kind of stringers with or without slats for cattle-guards ;

Wing-rails for planking on highway crossings ;

Automatic couplers for freight cars ;

The kind of steps and ladders upon freight cars and their location ;

Whether brake-cabooses or conductors' cars with good brakes, should not be run next to the engine on freight trains to help to take the weight of the train off the engine when steam is shut off and brakes called for, and which cars might be used for "peddling" freight ;

Whether passenger platforms at depots should be flush with the top of the rails, or be raised to the level of the first step of the coaches ;

The construction of coaches, ^{or cars} keeping the dead weight at a minimum, consistent with requisite strength of framing ;

The ventilation and mode of heating passenger-coaches, whether by stoves, hot water heaters, or by steam from the engine ;

The construction of brake-beams, brake-heads, and brake-shoes ;

The manner of notifying passengers of approach to stations, whether by brakemen or revolving indicators in cars ;

The best, cheapest, and most systematic way of getting passengers and their baggage to and from the large and important depots ;

The freight business is reasonably well handled in many respects so far as collection and delivery, but there is room for important improvement in getting passengers and baggage to stations; and without going into detail as to how passengers might be ticketed and baggage checked in city offices and baggage collected and taken to the train as our American system rather demands, it might not be out of place to explain how the baggage of the passenger is checked with a strap metallic check, attached to the baggage, the duplicate given to the passenger, he seeing that the number upon the check he gets, agrees with the number on the check put upon his baggage, as a precaution against mismatching, although the station baggageman is supposed to compare them before taking the check off the strap and handing it to the passenger;

For local or way baggage the number of the station is put upon a card or tag attached to the check, or the number of the station is chalked upon the baggage, and by these station numbers, the train baggagemen handle and work the baggage to destination.—

For through baggage, or baggage passing over several lines of railway a reversible check is used, the strap covering the name of the forwarding station and showing only the destination, this check can be used on the return trip by changing the strap and putting it through the eye-hole in the other way, so that the starting point covered by the strap going, becomes the destination on the return trip, when the strap is reversed;

The passenger with these metallic checks in his possession rests contented, he can leave his baggage at the depot by not claiming it at destination, or by giving his check to the omnibus agent or expressman, go his way knowing his baggage will be taken to whatever point he may name. This is a great advantage over the paper labels that plaster your baggage in Europe, and which even then, must be claimed at once on arrival of the train and on the depot platform.

The train baggageman shows on his waybill where numbers on checks, were taken on, and where left off; by these waybills baggage can be traced, if any mistake has been made in leaving it off.

Then there is the transportation of grain in bulk. It is unloaded into pits in the elevators, taken by metallic buckets upon belts into bins above, or taken from vessels by elevator legs, belts and buckets; scooped out from the hold, or shot into the hold by spouts from above. This is also a quick, cheap and effective process of cooling and cleaning grain. It is inspected, graded, weighed in and out, spouted into cars to be taken long distances and put into vessels or barges through other elevators.

This mode of handling grain is very different from the slow, expensive, old country style of bagging and storing.

~~Then~~ ^{also} there is the system of handling light freights, money, and valuable packages through the express transportation companies and by passenger trains which is also well worth considering.

Let me also call your attention to the system of handling live stock in the yards belonging to the railway companies; of feeding, watering, weighing, loading, or unloading and transportation winter and summer; the process of caring for stock on the journey, ~~of~~ ^{also} watching, watering and feeding, also the immense refrigerator car traffic in dressed meats, dairy products, fruits, oysters and fish, and last, though not least, the transportation and care of humanity in luxurious sleeping and dining cars, which for the long distance traffic is hardly surpassed on the other side of the Atlantic.

But you will think I have run you off upon one of these long switches to which I have referred, so we shall return to the train service. Suppose that we have properly equipped trains, and something to run with, and a suitable track to run upon, and trusty men in charge of the train; that would mean for a

passenger train, bodies of coaches and windows thoroughly cleaned, outside of axle boxes and running gear scrubbed with a brush and lye solution, and all oil and grease cut off; the running gear, and air brakes known to be reliable, the bell-rope properly strung from the engine cab to the end platform of the rear coach and tested to see that it is O. K.; the cars internally scrupulously clean, water coolers filled with fresh ice water, lamps trimmed, good ventilation, the temperature moderate, a thermometer suspended in the middle of the car to guide in regulating the temperature, the trainmen neat, clean, perfectly sober and in uniform, the baggageman in his car and the conductor (who is responsible for the working of his train, and the tickets or fares and comfort of his passengers) know that everything about his train is right, as regards signals, two red and two white flags, two red and two white and his own lamps, and the tail and side lamps, axe, saw, and hammer in each coach, and in his *tool box* in the baggage car a wrench, waste, oil, wick, detonating signals, dope, the proper signals on front of the locomotive, neither he nor his men smoking on duty and all alert and attentive to train work and passengers and baggage. Know before he starts from the telegraph office about trains due and their position.

On the journey, one brakeman should always be about upon the rear car, the other on the front end of the train near the baggage car, and the conductor upon nearing stations at which he means to stop, somewhere between the baggage car and the middle of the train and when he does stop and before he starts, his men can tell him by signal or voice whether everything is right front and rear.

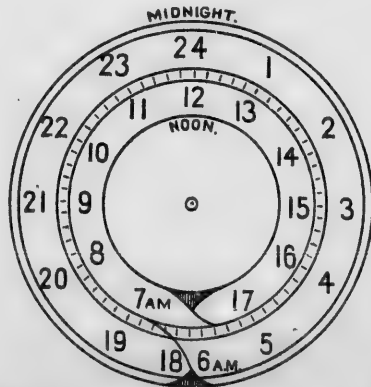
The freight train men should know that the running gear of their cars ~~was~~ apparently right so far as they ~~can~~ ^{can} see, the coupling links and pins of cars safe, no bolts dropped through the drawbars and used for ordinary pins, their caboose or conductor's car, neat, clean and comfortable, with their kit of lamp,

torpedo and flag signals complete, spare links and pins, a crow-bar, a set of portable frogs, a tail rope, two torches, chain, axe, saw, and wrench, supply of dope, or common brown soap and wood ashes, waste and oil.

If the train has a passenger coach and running as a mixed train there should be a bell rope strung from cab of engine through open cleats on the roof of the freight cars to the rear platform of the coach. The caboose car should have side brackets for tail signals.

These trainmen should be seen by the yardmaster before they leave and he should know positively that they are sober, fresh, and well rested, one brakeman on front (possibly on the engine), to operate from that end, the conductor and other brakeman on the rear end of the train. The peddling car with light station to station freight, should be near the front end.

There should be a standard time regulating the movements of all and everything in connection with the train service, certain clocks, in certain places as a guide and by which the men could regulate their watches, the time should be telegraphed at noon to all accessible points on the line, so that all clocks and men's watches could be kept *regulated*, and here let me call your attention to the proposed 24 hour dial to avoid the A. M. and P. M. Dr. Whitner's plan is quite ingenious.



The inside circle represents the working day time, the outer the night. After 12 noon deduct 12 from the figures on the dial and that gives the present hours.

There should be a working time card showing all the trains in each direction with their meeting and passing places. All trains likely to be run should also be shown; it is better to have them in the time card and to cancel them when freight traffic does not warrant them being run, than to make special arrangements and take risk of trackmen and others not being warned, besides at times it is convenient to have other trains, engines running light or with a caboose take and run upon that time.

The running regulations should be briefly but very plainly expressed, stating what time-rights trains had, to where, how trains were classified, what kind and how signals day and night are to be given.

The rights of trains in the event of some getting late and unable to make their time-table meeting points, are very important; the instructions regulating these should be so distinct that in the event of no telegraph arrangement, trainmen could safely proceed against and upon the card time of a train from the opposite direction, which had from some cause become delayed, and by the rules had to keep out of the way for a specific time; and as trainmen as a class are a sort of peripatetic lot of men changing from one railroad service to another, it is most important for railroad companies and their patrons that some fixed system of signaling and running should prevail upon all roads. We shall refer to this matter later on.

Meantime, let me suggest for our purpose, the adoption of the following signals, which to be seen, should be given upon the engineer's side of the engine or train, unless the train is upon a curve where the fireman can see better, and the signals should mean the movement of the engine in "going ahead" or "slacking back."

In daytime, motions with arms and hands.

To start ahead.—Elevate the arm above the head and wave the hand horizontally to and from the side of the train. The engineer just before starting from an important station should always have his bell rung, as a notice that the time is about up and that he is ready, he should also have it rung when approaching highway crossings and passing through station yards.

To stop.—Extend both arms horizontal from the body.

To back up.—Wave one arm and hand at wide range horizontal across the middle of the body to and from the side of the train.

To go slow.—Move one arm and hand vertically up and down toward the track.

Train broken loose.—Raise both arms and hands above the head.

In coupling up.—As the train approaches to be coupled up, keep the arms and hands raised above the head and bring the hands gradually together to indicate proximity to the disconnected portion of the train and finally give the signal to stop as the cars come together.

Fixed night signals.—White light, all right, go on; unless this light is moved in the manner described.

Green light, caution, go slow.

Red light, danger, stop.

Moveable night signals with a white light.

To start. Wave or shake the white light above the head, the same motion as with the arm and hand in day time.

To go slow. Raise and lower lamp slowly up and down towards the track.

To stop. Wave the lamp violently across the body to and from the side of the train or across the track.

To back up. Wave the lamp slowly in towards and across the body.

Broken apart. Give signal to stop, then swing the lamp in a circle above the head.

Coupling up. Use the back up signal, the go slow signal and stop signal as the two portions of the train near each other.

Bell-cord signals.—To stop. Two taps of the gong in the cab of the engine; one is objectionable, because if the train broke loose it would cause one tap, and the engineer shutting off steam would lead to the rear portion of his train colliding with the front.

To stop at the next station. Three taps of the bell, when the train is in motion.

To back up. Give signal, standing on track.

Reduce speed. Four taps.

The signal to start should not be given by the bell-rope, but by the conductor standing upon the track, with his hand or lamp. It always appeared to me to be a lazy and dangerous way of starting a train, to see a conductor standing on the platform between the cars, or in the inside of a car and jerking the bell-rope to start, not knowing what was going on outside upon the track.

Whistle signals.—Stop and signal for brakes. One short, sharp whistle.

Urgent danger. Several short sharp, decided whistles.

Release brakes, or for starting. Two short blasts.

Train parted. Three long and two short.

Back up. Three short blasts.

For a switch. Four short whistles, to be responded to by the switchman giving the slow signal.

Calling in flagmen. Five sharp blasts.

Approaching stations and junctions. One long whistle.

Approaching highway crossings. Ring the bell, not less than eighty rods distant from the crossing and keep ringing it

until the crossing is passed. Give three whistles, two short and one long.

To call attention to signal carried on the engine. Three long blasts.

For trainmen to hurry up. Several short, but not loud whistles.

In rare and urgent cases when a freight or inferior class train is in a side track, and wants to be flagged to the nearest telegraph station in the direction in which the passing train is going, so that this "laid out" train, as it is called, may get orders, a train of the same or inferior class may be signaled to flag it in daytime only, by the conductor of the "laid out" train standing at the front of his engine exhibiting a red flag held out towards the track, but depressed at an angle of forty-five degrees, and his engineer giving short, sharp whistles, so that the engineer of the approaching train can hear, and be answered by him in the same way; the fireman of the passing train shall then exhibit and put on the front of his engine a red flag and flag the train to the first telegraph station, and the engineer and conductor shall see that men on trains (if any they *pass*) are cognizant of this signal.

On the locomotive a mirror set up on the cab would enable the engineer to see and know the condition of his freight train, whether cars were running all right and in line, or when any of them caught fire, but he should have the ordinary locomotive head lamp in good shape, and I suggest with moveable numbers, to slide upon a bar in front of the glass, indicating the *number* of the train, for the guidance of the dispatcher, *train*, track, and stationmen; these should be put on by the engineer before starting. If it is an ordinary time card train, the card will indicate his number, if it is an extra train, the train dispatcher will give him his number, and his train will be known by that number on the journey. This head lamp should also have red and green curtains, that when necessity requires, can

be drawn across the face of the lamp at night indicating caution, or danger, or that the train is upon the side track and quite clear of the main track. The engineer can flash this signal in a moment from the cab of his engine by means of cords led from the lamp. These signals are made by oiled colored silk mounted on spring rollers set in tin cases as shown in the accompanying sketch.

The advantage is that the engineer can flash a large danger signal to an approaching train, or by pulling the green curtain indicate to the approaching train, whether he is upon the side track and clear of the main track and the switch all right.

The engineer carries the black tin plate numbers up inside of the roof of his cab, and these numbers slide upon a moveable bar, on the face of the lamp. They do not obscure the light and they shine through the colored curtain, and in day-time the numbers are equally distinct.

I think this train number *in front* is safer for passing trainmen and for stationmen, than the number of the locomotive painted on the side of the lamp, or the number displayed upon the caboose at the tail end of freight trains.

EXPLANATION OF LOCO. HEAD LAMP SIGNAL.

Figures 1 and 2 are perspective views of a Head Lamp having the improvements applied thereto.

Figure 3 is a detached view, showing the Coiled Spring which rolls up the screen.

Figure 4 is a Sectional plan of Figure 2.

Similar letters of reference denote corresponding parts in all the Figures.

A, represents the body of the Lamp which may be of any usual or desired construction.

It is in this instance provided with a Reflector B, and a Burner C, so arranged, that as much of the light as is possible, may be thrown through the circular face plate D.

E is a Signal Supporting Bar, mounted by preference in Slotted Lugs, or Ears, E 1, E 2 projecting from opposite sides

of Sash of face plate D. One end of this Bar is jointed, as at *e*, the short pivoted end hanging down by its own weight, and thus in connection with a pin *e* 1, which passes through the Bar, just inside of the Ear E 2, serving to lock said Bar firmly in position in the Ears, and guard against its accidental displacement, while, at the same time, the Bar can be easily removed by raising up the short pivoted end *e*, until it is in line with the rest of the Bar, then sliding it inward until that end can be removed from Ear E 2, and then moving the Bar in the opposite direction until its opposite end is disengaged from Ear E 1.

In figure 2, there is shown the number (8) affixed to the Bar. It is evident that Signals need not be confined to numbers, although in ordinary practice numbers will generally be found the most convenient.

In Figure 1, the numbers (2) and (23) are shown, which serve to explain the position numbers are placed in, when denoting different sections of a train.

These numbers are secured to the Bar by means of Sleeves—one to each figure—the Sleeve fitting the Bar with sufficient accuracy to insure ~~their~~ retention in place; when preferred, the Bar and Sleeve may be perforated to receive pins, or other equivalent fastening devices.

F F, are flexible Semi-transparent Signal Curtains or Shades. They are arranged behind—that is, inside—of face plate D, but in front of the light, and are rolled upon the roller containing the Spindle F 1. This Spindle is actuated by the Coiled Spring G (see Fig. 3), applied to one end of the roller in such a manner as to roll up the Curtain when left free to act upon it. H H, are Cords, the forked Ends of which pass over pulleys *h h*, and are attached to the upper and lower corners of the Shades, while the other ends are carried back into the Cab within convenient reach of the Engineer.

The position and arrangement of these Cords in the Lamps are fully shown in full lines in Fig. 4, and in full and dotted lines in Fig. 1.

It will be readily seen that by pulling upon the Cord, the Red or Green Shade as case may be, can be drawn across the open face of Head Lamp, so as to show a Red or Green Colored Light, at the will of the operator. The arrangements of parts being such that as this Curtain is drawn before the light, the tension of Spring G is increased so that when the Cord is released, the Curtain is automatically wound up.

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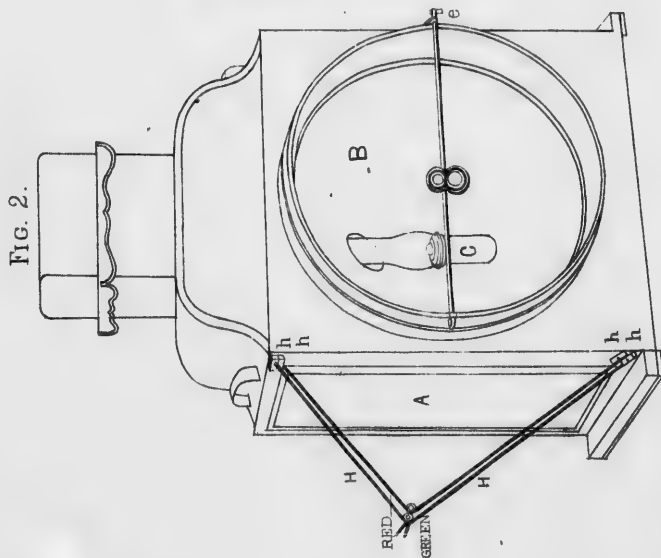
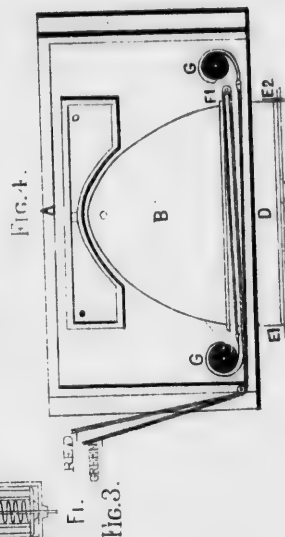
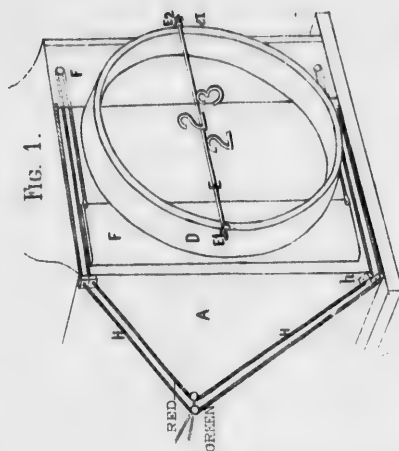
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There should be a side signal lamp at night on both sides of the tail end of all stock and freight trains—showing white ahead and red behind—and one red light on the tail end of all passenger trains.

The two red lights indicating a slower kind of a train, engineers following would be guided in the speed with which they would approach these lights.

The white front on the side tail lamps enables the men on the engine to know, from time to time, whether they have all their train.

When trains are being flagged at night, there would be, of course, the additional light in both cases.

The conductors and trainmen should have in day time in the rear car of their train, their red flags and torpedoes in readiness to protect their trains against others following. They should also, after dark, have in the same car two red lamps trimmed and lighted, also torpedoes ready for any emergency.

Flag and Lamp Signals on Trains. A red flag by day, or small red light by night on the front of an engine, should indicate that a train is following, and shall be waited for by a meeting train. A red flag, with white edges, should also be carried in daytime on the tail end of this same train for the same purpose, and to notify the trackmen that such a train is following close behind. Many of the trackmen do not look at the front end of a train, but have a habit of working to the last minute and only looking at the tail end as it passes, ~~and often, then,~~ because instructions from the roadmaster ~~are~~ ^{have} thrown off by him from the rear end of the passing train.

A white flag on the front of an engine, and on the tail-end of its train, should mean that an irregular train is following, but will keep out of the way of time card trains bound in the opposite direction; it would be a notification to trackmen and trainmen to be on the lookout for an extra train, although these men are supposed to be always on the lookout for and expect-

ing trains, so as *never* to be caught with their trains or their work unprotected.

For a *work-train*, working between certain points under permit from the train despatcher, there should be say two *yellow* flags on the front and rear, and of a different shape from ordinary white flags to prevent mistake.

Flagman's signals held in hand, and flag signals should always be *held*; it is very unsafe to stick them up upon the platform or in the track and leave them; they might be blown or knocked down. Flags should also always be mounted on poles, and not folded and carried in the pocket, to be hurriedly taken out in a crushed condition, and possibly only partly displayed.

The *white* flag, meaning all right, go on, unless waved violently, then it will mean danger—stop; green will mean caution—slow; red, danger—stop.

For the protection of car-repairers, and as a signal not to move the train or car upon which it is displayed, a red flag, with a white square in it, but the *red* edges to be broad enough all round to make it practically a stop, or danger signal.

Semaphore signals—daytime, all right, track clear; the semaphore arm lowered, or the disc upon edge not visible.

Caution—go slow. The arm lowered to the angle of forty-five degrees. **T.**

Danger—stop. The arm extended horizontally, or the disc fully seen.

These signals *at night* should show a white light if the track is clear.

If at caution—slow—the *spectacle* (on the end of the semaphore-arm lowered to the angle), would be a green light on the face of the white lamp. If at *danger—stop*—the red spectacle on the end of the arm would cover the white light.

If the *switch* is *set for the* side track, the *green* light would be visible; if for the main track, a *white* light; if a *three-throw* switch, the green light for the one switch and *double* colors for

the others, say two green, or purple and green. The shape of the discs in daytime would indicate which way the switch was turned.

Detonating signals should be clamped upon the top of the rail with a lead clip, one signal upon each rail, the one about 800 feet ahead or *six* telegraph poles distant from the other. These should be used in foggy weather, or after dark, or during a rain or snow storm, or at anytime when there was the slightest chance for a signal *held* upon the track *not* being fully seen, in fact the light might go out and it is best to use these torpedoes at once and quickly, one should be placed at least *seventeen* telegraph poles distant from the rear of the train to be be protected, and another laid six poles further away, and if possible one more as far back as *thirty* poles from the tail of the train that requires protection. The brakeman then returning towards his train, but keeping his signal at least 2,500 feet or 17 telegraph poles from his train, might take up one, or the middle torpedo.

Pyrotechnic signals. These should be lighted and thrown off trains, when from any cause the trains are not making running time and when followed by other trains, as a signal to following trainmen to be watchful and look out for trains not far ahead. There should be no hesitation or delay in using these as a precaution to guard against rear collisions, or adopt fuses set upon telegraph poles, operated in sections, to be lighted and set off by electricity, from distant points on the line, or from stations as a signal to approaching trains that the line is blocked; these could be set off by trainmen from district boxes set upon the telegraph poles.

The names of stations should be conspicuously set up upon posts or upon buildings at each end of the depot platforms, with the distances from the terminal points shown at each end of the sign board, for the information and guidance of passengers in the cars approaching and leaving the stations.

There should be distant semaphore signals with spectacled arms and lights worked from each end of the station platform and yards, or an electric arrangement in the track operated by the locomotive as it passed signaling by bell at the depot its approach and setting a block semaphore signal in its rear and releasing it, or lowering it, as the train left the depot on its journey.

Many of you may look upon these things as commonplace and know of them on European railways, but there is no uniform system of either signboards or signals in this country, and while the signals may be looked upon as expensive luxuries, they are not costly, and the safety of the traffic sooner or later, will demand the adoption of such ingenious and effective contrivances. Much, however, depends upon the considerate attention and reasonable amount of ingenuity displayed by the officers of the road in keeping pace with the requirements of the public safety, to say nothing of the traffic.

On the depot platforms, worked by and visible at all times to the telegraph operator from his office, there should be a semaphore disc and lamp as a telegraph train order signal to approaching and passing trainmen; this signal should stand at "stop for orders" unless held by the operator at "all right" no orders.

The practice of setting out on the platform a flag or lamp and trusting to either remaining there undisturbed, and to trainmen seeing them is most dangerous, because they might be interfered with by people on the platform. I saw a huge porker once, come on to a depot platform in Michigan and scratching itself against a signal flag pole, set up as a stop signal to an expected train, knock over the pole and flag!

There should also be a V shaped case or frame built in the upper part of the telegraph office window with changeable transparent signal figures showing number of train and time it passed, so that men, on following trains approaching and passing

from either direction, would see just when the preceding train had passed that station.

Having spoken of the track, the kind of trains, trainmen, and signals, let me now refer to the working or employe's time card and how it is made.

The mode of preparing one of these time cards is generally by having a diagram showing names of stations and side tracks *down* each side, spaced out to a scale of distances, and then a row of columns showing the hours say from twelve midnight to twelve midnight; the hour columns set off into five minute spaces and by taking thick and colored thread and pins stretch the thread from the hour at which you wish to start the train, to the hour at which you wish to arrive, and if the train is to use that running time, the hour at which the string touches the line running horizontal from the station or side track will give an idea of the time at which the train will pass that place, then with the pins set off the thread, allowing for grades in the track, times for refreshment, work at stations, or for killing or making up time to reach a passing place for the opposing train, which the thread run in the opposite direction will indicate, but all trains must cross each other on the horizontal lines, or trains would meet between stations. This you will perceive is a quick and safe method of blocking out a time card and making sure of having a proper meeting place for all trains on the time card. White threads may indicate passenger trains and colored threads various kinds of mixed, live stock, and freight trains. *what hours all show for each train (direction of travel).* This diagram shows at a glance how and what trains are run, how the track is occupied, and from this diagram the times of the trains are taken for making up the working time card.

The time card should be very legibly printed, upon good, stiff paper, that will stand the manipulation of the trainmen and the weather they have to encounter, the figures especially should be very plain type, and as the times of the trains going

in one direction have to do with those going in an opposite course, the pages have as a consequence to be much wider than those required for trains run upon a double track, because those columns for double track trains are complete in themselves, while for single track trains, the names of the stations and side tracks are generally printed down the middle of the sheet and the columns for times of trains put upon each side of the names of stations, the times of trains going in one direction reading down and those going in the opposite direction reading up, the figures in large conspicuous type denoting the meeting and passing points, if the trains are on time, and by running the eye across the columns from any one of those large figures to corresponding figures in other columns, the trains to be met are at once discovered. At the top of each column the *even* numbers denote trains going in one direction, and the odd numbers indicate those going in the opposite way.

The time card should show at important stations the arriving and leaving time; at other points where only one time is shown, it should mean the time of departure; trains should not leave ahead of time shown. The heavy figures show times and places of meeting, if trains are running on time and these points *must not* be passed, unless the train to be met is late, and the rules give right of way toward a certain point after waiting so many minutes, *or* the conductors and engineers are furnished with a telegraphic train order to pass. But if the train has no telegraph order, and is running by time card rights, it must run keeping the specified number of minutes late until the train it should have met, *is passed*. The other or opposing train runs of course keeping out of the way of the train that has the rights, and runs just so many minutes late as prescribed by these time card rules.

Five minutes should in all cases be allowed for variation in watches, but this time should not be used to run upon.

Superior class, or passenger trains on the time card, have the

right of way over all kinds of inferior class trains, and they must be kept off the time and out of the way of these passenger trains.

Mixed trains; that is, freight trains with a passenger car attached, should have rights over live-stock and freight trains, and live-stock over freights, and all time card inferior class trains have rights over "specials" in the absence of special arrangements.

At meeting stations, superior class trains keep the main track; inferior class trains take the side track. When trains of the same class meet; the one having the right of way by time card is entitled, when there is only one side track, to keep the main track; when there are side tracks on each side of the main track, and inferior class trains going in both directions meet a superior class train, the inferior trains take the side track prescribed for them going in their specific direction, trains going in one direction always taking their own side, thus avoiding dispute as to which side of the track certain trains take, the only exception being for a long or heavy live-stock train unable to take the side track, when the superior class train has to give way and take the siding.

When a train breaks in two, the engineer must not stop, nor be stopped with the forward part until he knows that the rear portion has been brought to a stand, nor back up to couple on, or to look for the rear portion until he is signaled to do so. If he has any distance to go, he should not move until a signalman is upon top of the train, if a freight, or upon the rear platform, if a passenger, and he is signaled by a flagman ahead before rounding curves; if another train is following, he will not back up unless specially arranged for, as it may be best for him to go on to the first side track and let the following train push his detached portion up to him; or to leave what he has, and to return and help or clear the track for the following train.

If any of his brakemen are with him, they will consult the rules and be guided by them first, and then by the circumstances of the case.

Inferior class trains wait indefinitely for superior class trains when late, unless their men get telegraph orders varying from the time card rules.

When freight trains are forty-five minutes late, road or construction trains whose men's time is valuable and costly may use the main track, their conductors first protecting them by signalmen at each end of the "beat," and get out of the way when the freight train comes in sight, always running from it, the men on the late freight train knowing where the road train is working, keeping a lookout for it.

The trains on the time card should be run as much as possible by time card rules, and the fewer telegraph arrangement orders the better; it is a mistake, increasing the number of train orders, giving opportunity for confusion, miscalculation and mistake, but the despatcher's office, nevertheless, is a necessity, while he sits and watches and records the movements of the various trains and keeps them moving when any of them become irregular, and keep them as much as possible on time, to make connections with other company's trains, and to avoid the loss of time to live-stock and freight trains, and men and engines waiting for irregular passenger trains; keeping engines and men waiting on side tracks is an expensive and discouraging operation.

As the train despatcher's office is, I think an institution peculiar to this country, you can readily imagine the kind of telegraph operators necessary for this important and responsible work. They should be cool, quiet, sober, systematic, sharp, intelligent youngish men, with the very best of memories, quick, sound operators, that is, operators not working by the needle, or dial, or paper, but by the *clicking sound* of the instrument, knowing the line of track thoroughly, its con-

dition, curves, grades, location of side tracks, shape and construction of yards at depots, the kind and the "true inwardness" of trainmen in charge of trains for whom they make telegraphic arrangements and to whom they issue orders; they should also know the condition of the locomotives on the trains, weight of train and so forth, which experience gives them in time, so that in making their calculation of distance to be run, they can the better apportion the time in arranging a meeting point for some other train.

Their office should be in a quiet, private, central locality; the mileage of the district under their charge should be regulated according to the number of trains and extent of traffic upon it. If a long line, it should be in divisions. Each set of dispatchers occupied in working trains only over their own division. Their time on duty should be from six to eight hours according to the nature of the work, the mental strain is often quite fatiguing.

There must be only one dispatcher giving orders on each division, and he should have a first-class, sound operator helping him. This operator chosen because he was likely to be the making in time of a dispatcher. This operator would write out the orders as he heard the dispatcher sending them, and the dispatcher would see what he was sending. The two need not speak to each other. The dispatcher untrammelled has only his train movement diagram to watch, as the operator from time to time records the reports from stations of the passing of trains and the dispatcher watching the movements of the various trains, he with the key of his instrument in hand, sends the orders he plans and calculates, and sees them recorded by his operator, and watches their acknowledgement by the receiving station and trainmen, and finally and at the proper time gives his O. K. completing the train order. These operators should not come on and go off duty with the dispatcher, but have their time on duty "LAP OVER" the hours of the relieving

despatchers, thus helping to dovetail as it were the work of one despatcher into that of the other, because orders of one given might not be fully carried out when it was his hour for "off duty."

The despatchers have a skeleton time sheet for each day of 24 hours and for each of their divisions, showing the names of stations and side tracks with distances; these run down the middle of the sheet, with the columns on each side, showing actual times of each train movement as reported from *outside* telegraph offices.

The despatchers are thus enabled to watch train movements and calculate and arrange for meeting and passing points when their assistance with the telegraph is needed and can be profitably used.

When these arrangements are necessary and orders are to be issued, the despatcher handling the key of his instrument calls up the operator at the distant point, who sees that his station order signal is set for stop, and says so; then receives the order sent to the trainmen first affected. The despatcher's operator, as I have already explained, takes by sound and records in his book the message with date, time, to whom sent, number of train, at what station, and signing the superintendent's name with despatcher's initials, so that distant operators and trainmen know who sends the message.

This order is taken down by the receiving station operator in a manifold writer making three or more copies (three at least), one for himself and one for the engineer and one for the conductor affected, repeats the order back to know it is right, but keeps these messages until these trainmen arrive and sign the copy in his book; and only when the men fully understand the order and sign the book copy, and that is reported back with their signatures, and the train despatcher gives his O. K., can the order be taken and acted on. The despatcher in the meantime has been in communication with the station operator in the

opposite direction, giving orders to the opposing trainmen, naming the meeting point, the two messages being practically alike, and the train having been held by the "order-signal," these two trainmen in like manner sign the station copy and the message with their signatures repeated back, and the despatcher's O. K. obtained, the "order-signal" boards are changed for the time being and the two trains proceed to the fixed meeting point; the despatchers thus control the arrangements for meeting and passing up to the last moment, and just up to the moment the trains are ready to leave.

The operator at the point where the trains are to meet having heard the arrangements made, notifies the station agent, who prepares for the reception of these trains at his station.

All operators should keep their offices quiet and private; they should be good, expert penmen, have their books for train reports, and train movement manifold books and carbon paper ready for instant use; all orders given in the fewest, clear, explicit words (no alterations or erasures) upon stereotyped forms, which are printed in blank to suit the various cases of train movements, one order for each meeting place, and it should never be "hampered" with messages upon other subjects. If there is an order to trainmen about any matter not actually connected with the train movements and meeting of trains, it should be separate and distinct upon another form.

Telegraph train orders, as I have said, should be upon printed blank forms, with spaces for number of train, name of station, names of conductor and engineer, time, date, and for the signatures, and be for the specific cases of train orders ordinarily required for this train work—such as orders for trains to run to a fixed meeting point; or for passing a train running ahead; or a fixed time order to run to some place consistent with the time card running time; or for some irregular train running to some fixed point regardless of certain other trains kept out of the way; or for cancelling certain trains, abandoned on account of light

traffic, although on the time card; or for cancelling an order that had been given and through the failure of one of the trains to make time had rendered the order unavailable; or a clearance; or a holding order holding a train at a point until a certain time for the arrival of a train that had been given to that time to make that specific place; or holding a train at some point on account of an accident. Numbers should, in these train orders, be spelled in full, and the numerals should also be given.

The engineer, after he reads and thoroughly understands these train orders, puts them before him on a hook or clip in the cab of his engine, and the conductor, like the engineer, keeps his orders until he reaches the end of his journey.

When telegraphic orders are given, each train should, as much as possible, have its specific orders and not be run under flags, and flags should never, as a rule, be carried for trains, unless so ordered by the despatcher, and even then, if to follow a train under the same rights, not unless the train is quite ready to start and follow promptly and able to keep up with the train flagging it.

When *telegraph* messages are sent by passing trainmen, to disabled or "laid-out" trains at intermediate or non-telegraph stations, these should be in duplicate, so that the conductor carrying the message can get the duplicate copy signed by the men with whom he leaves the other copy, and that signed message should be telegraphed from the first telegraph office to the despatcher, so that he may know it has been delivered.

Numbers are given to time card trains by the time card, and to special or extra trains, or work trains by the despatcher, who takes a number so far beyond those on the time card that operators and trainmen know that the number indicates an extra train. Fresh numbers are taken at the beginning of each week and run consecutively through to its close. Some roads use the numbers on the locomotives.

Road, or work trains, or pilots, or pushers, may be known through the week by the same specific number given them by the despatcher. The conductor of the road train agrees with the despatcher at the close of each night's work, where he will work on the morrow, and gets his permit, or train orders, accordingly, confining his runs to that district. Other trainmen interested are notified of the location of these road or work trains.

A bulletin board in the despatcher's office should have a list of these trains, with numbers and points between which they are working.

These road trains would, as a rule, work under flags, and keep out of the way of all time card trains, unless run under special telegraph orders.

Night operators should report each hour to the despatcher, so that he may know they are awake and ready for business. Day operators also report on and off duty.

In case of accident to the telegraph office semaphore or lamp, operators should always, after dark, have a trimmed and lighted red lamp, and in day time a red flag upon a pole, ready for immediate use.

The essence of this whole operation means: — "eternal vigilance in each and all of the departments."

Having thoroughly intelligent, cool-headed, practical officers, devoting their time to their duties, keeping pace with the times in needed economical improvements; employing only sober, intelligent, honest, provident, youngish men, whose appearance, manner, general conduct and discipline would likely entitle them to that promotion their reasonable ambition and length of service would warrant them to expect.

Having a time card that permits steady, safe running, suited to grades and other conditions of the track and work to be performed, and not too much unnecessary time allowed on some portions of the road and too little upon others.

Having the running rules simple, brief and explicit, covering all ordinary contingencies that might be expected to arise in the

train service, the time card being used as the main guide in working, and the despatcher and his wire used only when necessary to save time on the journey, keep trains on time and insure safe running and connections, the system of signals *uniform* all over, simple and well defined.

The despatchers fully posted as to the track and stations, condition of the locomotives, and calibre of the trainmen; and they and their operators in quiet, private offices; the right men in the right place; their rules and forms of train orders simple, explicit and fully understood, and *obeyed*.

Trainmen careful, watchful and respectful, always on the look out and ready for signals.

Trackmen considerate and watchful for trains, while they perform needful repairs, and on wet, stormy nights be on the look out with signals for wash-outs or damaged track, and in winter for broken rails.

The officials, adopting, after careful consideration, such improvements as may from time to time be presented for the safety of life and property and economical working of the traffic, such as steam or air brakes upon all engines, freight as well as passenger; air brakes upon all coaches; safety platforms and couplers; caboose cars with specially good brakes on the front and rear of all freight trains; one of them can be used for pick-up peddling or way-freight; draw-bars on freight cars that have automatic couplings; steps and ladders on freight cars that are arranged with some decent regard to the safety of the brakemen when complying with the rules; electric lights in depots, and yards and on engines. The various conventions of railroad men will lead to such things being developed; the meetings of railway superintendents, master mechanics, master car builders, car accountants, master car painters, roadmasters, conductors, yardmasters, train ~~despatchers~~ *despatchers*, and so forth, are all steps in the right direction to develop ideas and agree upon standard

and uniform working for the general benefit of railroad companies and their patrons, and patrons in turn helping railroad officials to get more work out of their freight car stock, for in this country and unlike yours, demurrage is not enforced, and the loss of the use of freight cars by using them as storehouses at depots and side tracks is simply ruinous, the average mileage per car per month is dreadfully small, compelling railroad companies to own or hire more cars than the business actually warrants.

In conclusion, let me say, railroad officials should always exhibit a visible desire to meet and satisfy the reasonable requirements of patrons and traders, being prompt and attentive to promises, and ~~have~~^{having} some concern and anxiety for the interest of the employees when they are not upon duty. How many of the men when they finish their trip, and away from their homes or boarding houses, are left to wander about, subjects for temptation, led away to spend their time in questionable places—losing money and reputation—in place of spending their time in rest and recreation nearer their work, and coming on duty fresh, rested, sober, cool and collected—come in a sleepy, dreamy condition not seen *but felt* through the working expenses column. I need not picture the result; no railroad is complete without employees' reading, recreation and resting rooms, well and attractively kept by elderly, sensible christian men, who will watch and advise and take an interest in the welfare of employees at all terminal points. Nor is the working of the railway complete without some fair and acceptable medical and insurance associations for the benefit of the employees and their families.

This almost suggests an allusion to some of the amusing, and yet often dreadfully unjust and severe claims, that are made upon railroad companies for compensation; but as this does not specially belong to *single track* railways, and would come with a better grace from some railway solicitor, I will close, thanking you very much for your very patient hearing.

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